

## Transit Connections: Bus Stop Locations

### Introduction

The 2008 High Capacity Transit (HCT) plan identified a vision for developing a multimodal center that ensures coordination of bus and light rail services in the vicinity of the Montlake Triangle and Montlake Interchange. The vision outlines the importance of pedestrian and bicycle movements, fast and reliable transit services, connection between local, bus rapid transit, and light rail service, and maintaining the open character and accessibility of the area.

Analysis of ridership projections from the 2008 HCT planning effort indicate most riders traveling to the Montlake Triangle area are going directly to or from the UW campus. When the Montlake Triangle area is the end of the light rail line, approximately 60% of transit customers will be destined for the UW campus and Medical Center, another 20% will transfer between buses and 20% will transfer from bus to light rail at the Sound Transit UW station. Less than 1% are expected to walk to the light rail station from the neighborhoods south of the Montlake Cut.



Figure 1 (Dec 2008). Projections of transit rider and pedestrian destinations in the Montlake Triangle area, prior to the extension of light rail to Northgate.

To address the removal of the existing Montlake freeway station, the HCT plan identified options for future transit connections for local and regional service in the Montlake Triangle area. The HCT plan recommended relocating and expanding bus stops at the Montlake Triangle to provide key transit connections for riders traveling between north Seattle, the UW campus, and the eastside communities of Bellevue, Kirkland, and Redmond. The plan identified necessary operating investments and capital

costs, including service hours, bus fleet requirements, transit stops with adequate capacity for layover storage and bus bays to accommodate higher volumes of buses at peak periods.

Bus stop locations in this area need to accommodate transfers between services as well as rider origins and destinations. In the Montlake Triangle area, riders may be transferring between buses or between buses and light rail, though a majority of transit users will be destined for the UW campus or the Medical Center and UW Health Sciences facilities. Along Montlake Boulevard at the SR 520 interchange, transfers may occur between local bus service and the regional bus service at SR 520, while also serving residents in the Montlake neighborhood and, currently, some riders accessing the UW campus from the freeway station by foot or bicycle. In addition to this transfer activity, nearly 6,000 riders each day are traveling through the Montlake Triangle in both directions to destinations to the north, to the Eastside and to communities south of SR 520.

Key considerations in the evaluation of bus stop locations were to:

- Improve transit speed and reliability between E. Roanoke Street and the Montlake Triangle area without significantly adversely affecting traffic operations on SR 520.
- Minimize any increased right-of-way needs beyond what the I-5 to Medina SR 520 Preferred Alternative currently requires.
- Optimize walking distances to key destinations on the UW campus and the UW station.
- Accommodate potential future transit stop locations and capacity requirements.
- Accommodate current and proposed local and regional bus transit service.
- Accommodate the ESSB 6392 definition of “effective transit connections” to be distances less than 1,200 feet between surface transit stops and the UW station.

#### *How were bus stop locations addressed in the preferred alternative?*

The preferred alternative suggested bus stop locations on the westbound and eastbound HOV direct-access ramps; however, the preferred alternative did not specify bus stop locations on Montlake Boulevard or in the Montlake Triangle area. The 2008 HCT plan recommended the creation of a multimodal transit hub in the Montlake Triangle area, and suggested an expanded bus stop on NE Pacific Street between NE Pacific Place and the existing taxi/patient drop-off/pick-up location.

#### **Addressing the problem**

##### *How did we identify possible solutions?*

WSDOT, Sound Transit, King County Metro, the City of Seattle, and UW all have plans, projects, or services that affect transit rider and pedestrian access in the Montlake area. A subgroup of the Technical Coordination Team (TCT) members with transit expertise met regularly to discuss key planning and design principles that would influence proposed bus stop locations. In evaluating options for stop locations, the subgroup considered a range of qualitative and quantitative data, including: the 2008 SR 520 HCT plan; projections for future transit ridership; route planning; design and construction plans; and *Complete Streets* considerations including City of Seattle plans and projections for future transit, bicycle and pedestrian infrastructure and connections. The subgroup identified eight potential locations for bus stop locations in the Montlake Triangle, three options for Montlake Boulevard stops near the

interchange (two northbound, one southbound), and three bus stop options at the HOV direct-access ramps on the Montlake lid.

The TCT subgroup developed the following criteria to consider potential bus stop locations:

- Montlake Triangle stops
  - *Ridership origin/destination.* Will the location provide transit riders destined for the area with the shortest average walk to and from their destination?
  - *Traffic operations.* Will the location result in a positive or adverse effect on traffic operations in the localized area?
  - *Travel times.* Will the location have an effect on the average total travel time for transit riders (bus trip plus walk to/from the destination), including those who are not destined for the Triangle area?
  - *Compatibility with UW station and Husky Stadium plans.* Will the location and associated operations support or impinge upon current projects and planning?
  - *Adequate bus/stop space.* Is there an appropriate amount of space for the facility?
  - *Constructability.* Does the location have special considerations or requirements for design and construction?
  - *Layover.* Would the option allow for current and future use of adequate curb space for bus layover?
- Montlake interchange stops
  - *Ridership origin/destination.* Does the location of the Montlake interchange stops provide a convenient transfer point between local bus service on Montlake Boulevard and regional bus service on SR 520? It is assumed the surrounding neighborhoods will continue to be served by local bus routes and stops, and that many bus riders will continue to transfer in the Montlake interchange area between SR 520 service to the east and local service to the south.
- Direct-access transit/HOV ramp stops
  - *Transit operations.* Is the location as close as possible to Montlake Boulevard bus stops and pedestrian and bicycle facilities, while avoiding significant delays to HOV traffic?

What options are presented for TCT consideration?

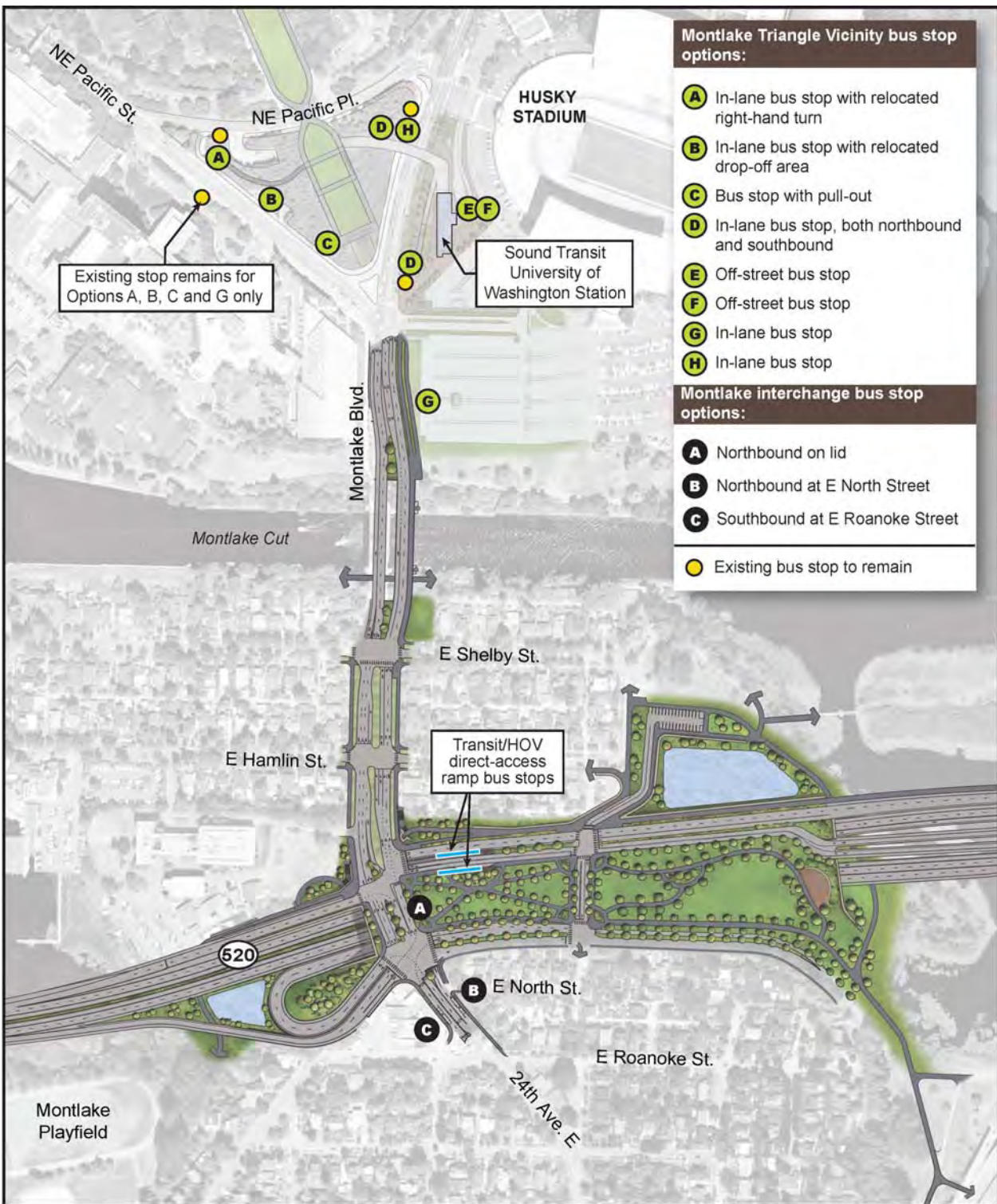


Figure 2 (September 2010). Montlake Triangle and Montlake interchange vicinity bus stop locations

### Bus stop location options at the Montlake Triangle

To help evaluate the effectiveness of transit connections for bus riders and pedestrians in the Montlake Triangle, each transit stop option includes the following supporting documentation: the bus stop location for each option considered; approximate siting of the required 220 feet bus bay at each stop; bus circulation routes; estimated pedestrian walk times to specific destinations identified below; the distance between proposed bus stops; the estimated transit travel time along these routes; the total daily person delay for riders traveling through the area and qualitative analysis on potential traffic impacts.

#### *Pedestrian walk times and distances*

Pedestrian walk times were calculated between each of the transit stop options and three destinations: 1) the Medical Center T-wing pedestrian bridge at the Burke Gilman Trail, 2) UW main campus/Burke Gilman Trail, on Rainier Vista over NE Pacific Place, and 3) UW station elevators at Montlake Boulevard. The walk times assume a walk speed of 4 ft/sec, and include the average delay experienced at signals. The delay a pedestrian would typically experience at a signal assumes a random arrival with some pedestrians experiencing no delay (arriving when a walk sign is on) and some pedestrians experiencing the greatest delay (arriving as the walk sign turns off). The time included in the analysis is the average of all pedestrians as calculated by the SR 520 VISSIM model.

#### *Traffic operations*

Several of the stops require intersection modifications to provide the movement necessary for bus operations. Traffic operations were evaluated for each bus stop location to determine the average delay at signals and estimate the effect on local traffic and bus operations due to the intersection modifications.

#### *Transit travel times*

For each of the transit stop options, bus transit travel time was calculated between the Montlake Cut and the NE Pacific Street/NE Pacific Place intersection. Similar to the pedestrian travel time, the transit travel time includes the route, the delay experienced at signals, and a dwell time of 30 seconds at transit stops. Travel times are reported as absolute, not in addition to existing travel times today. Travel times assume speeds of 25 mph on the arterials and 15 mph when travelling through the UW parking lot.

#### *Total daily person delay while riding transit*

Total daily person delay is the estimated amount of additional time that transit passengers will spend en route to their destinations based on different Montlake Triangle routings. Added travel time impacts the convenience and desirability of using transit. Nearly 6,000 riders per day, in both directions, are traveling through the Montlake Triangle to points north, to the Eastside and to communities south of SR 520. Options A, B and C all assume no appreciable routing change through the Montlake Triangle and are assumed equal to baseline conditions. The difference between the transit travel times of Options D, E, F, G, and H and the baseline travel times was assumed to be the transit delay for each transit vehicle trip through the Triangle. This delay was multiplied by the current daily directional ridership through the Montlake Triangle to calculate the total daily person delay.



**Option A**

*Westbound NE Pacific Street, nearside NE Pacific Place.* This option reflects recommendations from the SR 520 HCT plan, which suggested relocating the northbound bus stop on NE Pacific Street just to the south of its existing location. This option maintains the existing taxi staging area, but relocates the right turn lane between NE Pacific Street and NE Pacific Place to provide the required 220 feet for a pull-out. The existing southbound bus stop on NE Pacific Street would be relocated slightly to the east and would also require 220 feet for an in-lane stop. North-to-westbound buses would maintain the existing route after crossing the Montlake Cut (north on Montlake Boulevard, then left on NE Pacific Street). Eastbound buses on NE Pacific Street would also use the existing route between NE Pacific Street and the Montlake Cut.



**Pedestrian Walk Times**

Northbound		
To	Distance	Time
1	566 ft	2 min 45 sec
2	555 ft	2 min 19 sec
3	948 ft	3 min 57 sec
Southbound		
To	Distance	Time
1	740 ft	3 min 52 sec
2	790 ft	4 min 5 sec
3	1010 ft	5 min 13 sec

**Transit Travel Times**

Northbound	1 min 24 sec
Southbound	1 min 42 sec

**Option A Travel Times - Person delay while riding transit**

(Option A assumed to have no travel delay compared to existing condition)

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	0 min	0 hr
SB	6,000	0 min	0 hr

*Benefits:* These bus stop locations will result in minimal to no adverse effects on traffic operations and travel times over the existing condition. For the minority of riders who transfer at this location, this option may improve transit connectivity between bus-rail and bus-bus via new pedestrian pathways and shorter existing pathways. This bus stop option serves the majority of projected transit riders by providing similar distances and walking travel times as currently experienced today. Riders destined for the UW campus or UW Health Medical Center experience relatively short walk distances and multiple pathways. For the 20% of transit riders who transfer between bus and rail at the Triangle, the walking distance between these bus stops and the UW station is approximately 1,000 feet.

*Challenges:* The right turn lane from westbound NE Pacific Street to NE Pacific Place would be relocated for this option to accommodate the 220-foot bus bay. Further evaluation would be required to reduce the potential turning movement conflicts at this location.

#### *Option B*

*Westbound NE Pacific Street, at current taxi pull-out.* This option relocates the bus stop on westbound Pacific Street to the existing taxi/shuttle bus pullout directly across from the UW Medical Center, requiring relocation or elimination of the taxi/shuttle staging area. This in-lane bus stop would require 220 feet for buses to serve the stop. The existing bus stop on NE Pacific Street in the eastbound direction would also be relocated slightly to the east.

North-to-westbound buses would maintain the existing route after crossing the Montlake Cut (north on Montlake Boulevard, then left on NE Pacific Street). East-to-southbound buses on NE Pacific Street would also use the existing route between NE Pacific Street and the Montlake Cut.



### Pedestrian Walk Times

Northbound		
To	Distance	Time
1	660 ft	3 min 8 sec
2	535 ft	2 min 14 sec
3	926 ft	3 min 52 sec
Southbound		
To	Distance	Time
1	740 ft	3 min 52 sec
2	790 ft	4 min 5 sec
3	1010 ft	5 min 13 sec

### Transit Travel Times

Northbound	1 min 24 sec
Southbound	1 min 42 sec

### Option B Travel Times - Person delay while riding transit

(Option B assumed to have no travel delay compared to existing condition)

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	0 min	0 hr
SB	6,000	0 min	0 hr

**Benefits:** Relocation of bus stops in this option will have little to no effect on intersection operations or transit travel times over the existing condition. Similar to Option A, riders making bus-rail or bus-bus transfers will be offered slightly better

connectivity between stops via new and improved pedestrian pathways and route choices. This option serves the majority of projected transit riders with similar and efficient walking travel times. For the 20% of transit riders transferring between bus and rail at the Triangle, the walking distance between these bus stops and the UW station is approximately 930 feet and 1,000 feet, for northbound and southbound buses respectively. This option does not require modification of the right turn lane from Pacific Street to Pacific Place.



**Challenges:** The existing taxi/shuttle pull-out would be relocated or eliminated, an option that needs to be further evaluated by the University of Washington. Additional analysis is also needed on a potential crosswalk at this location that would provide a faster connection for riders walking to and from the UW Medical Center.

### Option C

*Westbound NE Pacific Street, near south corner of Triangle.* This option would move the stop closer to the southern corner of the Montlake Triangle, just west of the intersection of Montlake Boulevard and NE Pacific Street. The pull-out stop in the westbound direction would require 220-feet and would remove buses from the traveled roadway to minimize impacts to traffic operations at the adjacent Montlake Boulevard/NE Pacific Street intersection. The existing bus stop on NE Pacific Street in the eastbound direction would also be relocated slightly to the east.

North-to-westbound buses would maintain their existing route crossing the Montlake Cut (north on Montlake Boulevard, then left on NE Pacific Street). Eastbound buses on NE Pacific Street would also travel the existing route between NE Pacific Place and the Montlake Cut.



### Pedestrian Walk Times

Northbound		
To	Distance	Time
1	960 ft	4 min 23 sec
2	425 ft	1 min 46 sec
3	813 ft	3 min 25 sec
Southbound		
To	Distance	Time
1	740 ft	3 min 52 sec
2	790 ft	4 min 5 sec
3	1010 ft	5 min 13 sec

### Transit Travel Times

Northbound	1 min 24 sec
Southbound	1 min 42 sec

**Option C Travel Times - Person delay while riding transit**

*(Option C assumed to have no travel delay compared to existing condition)*

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	0 min	0 hr
SB	6,000	0 min	0 hr

*Benefits:* These bus stop locations result in minimal to no effect on traffic operations or transit travel times over the existing condition. Similar to Options A and B, riders making bus-rail or bus-bus transfers will be offered slightly better connectivity between stops via new pedestrian pathways, route choices, and improved pedestrian pathways. Option C serves the majority of projected transit riders

with similar and efficient walking travel times. Riders destined for the UW campus or UW Medical Center experience relatively short walk distances and multiple pathways for travel. Option C is somewhat further from the UW Medical Center than A and B. Adequate space exists for a two-bay bus pullout; however the underground Triangle garage limits the width of the sidewalk/ bus stop area at this stop location.

*Challenges:* The Triangle garage structure may limit the ability to construct a pull-out and bus stop or may require design modifications. Delay to through transit passengers resulting from buses merging into general purpose traffic after serving the pull-out bus stop was not calculated, but would add travel time to transit trips.

**Option D**

*North and southbound stops on Montlake Boulevard adjacent to the UW station.* These stops currently exist. The northbound stop is just north of Montlake Boulevard and NE Pacific Street and the southbound stop is located just south of the Montlake Boulevard and NE Pacific Place intersection. The northbound stop is in the current plans for the Sound Transit UW station project. The southbound stop is included in the current Montlake Triangle Improvement Plan. Both stops are currently served by the Route 243, which has three morning trips and two evening trips. Increasing the number of bus routes serving the northbound and southbound stops would require expanding these stops to accommodate 220-foot in-lane stops.

Northbound Montlake Boulevard buses would remain in the outside lane after crossing the Montlake Cut to the existing bus stop near the UW station, then continue north towards University Village and beyond. North-to-westbound buses would also remain in the outside lane after crossing the Cut to the existing stop, then change lanes to turn left at the traffic signal at NE Pacific Place, then continue west to NE Pacific Street. Eastbound buses on NE Pacific Street would turn left onto NE Pacific Place and turn right on Montlake Boulevard to the southbound bus stop. Buses headed south on Montlake Boulevard would change lanes and continue through the Montlake Boulevard/NE Pacific Street intersection. Buses exiting layover at NE Pacific Place would remain in the outside lane and turn right on NE Pacific Street for routes destined west of NE Pacific Place.

Option D includes an additional turn lane to allow for the northbound movement from Montlake Boulevard to Pacific Place, and would require signal modifications to provide green time for this movement. This additional movement causes the intersection to degrade in operations and would be 16% over capacity, resulting in significant congestion approaching the intersection. The typical queue for the two northbound lanes on Montlake Boulevard approaching Pacific Place would extend past Pacific Street. As a result, northbound transit trips that stop on Montlake Boulevard near the rail station would need to merge across two lanes of queued vehicle traffic to access the northbound left at Pacific Place. A mid-block transit signal queue jump and bus pull out could be installed to allow buses to make that crossing; however, it is likely that additional congestion would result from the added signal and irregular timing associated with bus arrival. Another option would be the addition of a northbound through lane at the Montlake/Pacific Place intersection that would improve operations and reduce congestion.

Southbound transit trips would experience additional congestion as they are routed through the southbound through movement of the Montlake/Pacific Street intersection. Today those southbound trips are able to use a queue jump that exists from Pacific Street to Montlake Boulevard. This southbound transit movement could be improved by providing a transit only through lane on Montlake Boulevard through the Pacific Street intersection that would connect into the HOV lane starting near the Montlake cut. With this change, the southbound route would still have over a 2 minute travel time.

**Pedestrian Walk Times**

Northbound		
To	Distance	Time
1	1470 ft	7 min 15 sec
2	825 ft	3 min 26 sec
3	255 ft	1 min 4 sec
Southbound		
To	Distance	Time
1	1200 ft	5 min 0 sec
2	380 ft	1 min 35 sec
3	390 ft	1 min 38 sec

**Transit Travel Times**

Northbound	4 min 6 sec
Southbound	3 min 8 sec

**Option D Travel Times - Person delay while riding transit**

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	2 min 31 sec	251 hr 40 min
SB	6,000	1 min 32 sec	153 hr 20 min

**Benefits:** Bus riders transferring to UW station or going to the UW athletic complex would have more direct access.

**Challenges:** Bus riders destined for the UW campus or Medical Center would experience increased travel time of 3-4 minutes, compared to current

conditions. Transit service would be re-routed to accommodate this stop location, resulting a delay of 1 ½ -3 minutes for local transit riders traveling through the Montlake Triangle area compared to existing conditions. As described above, an in-lane stop at this location would have impacts on traffic operations on Montlake Boulevard that would affect general purpose traffic as well as bus operations. The left turn movement at the NE Pacific Street/NE Pacific Place intersection would impact traffic operations on Montlake Boulevard. Because the intersections of NE Pacific Street/NE Pacific Place on Montlake Boulevard are closely spaced, it is likely that buses would have difficulty changing lanes across Montlake to turn left onto NE Pacific Place. Southbound buses could not use the HOV lane and queue jump at the NE Pacific Place/Montlake Boulevard, resulting in impacts to bus travel times and traffic operations. Transit could not use

inside HOV lanes planned for northbound Montlake Boulevard or the transit/HOV lane configuration would need to be re-evaluated to have the lane serve this stop.

*Option E*

*UW station at NE Pacific Place/Montlake Boulevard.* Buses would enter and exit via the Montlake Boulevard/NE Pacific Place intersection. Buses could make a stop adjacent to or near the UW station. This option would require the construction of a transit center to accommodate northbound and southbound buses.

Option E includes signal and capacity modifications at the Montlake Boulevard/Pacific Place intersection. A westbound through lane would need to be provided to allow buses to exit the UW station lot. Adding the westbound movement at the intersection would cause the intersection to operate at 9 percent over capacity. Traffic traveling northbound at the intersection would back up past Pacific Street. The northbound transit trip travel time would increase to 5 minutes and 25 seconds. This includes about twice the distance to travel plus additional delay to travel through the Montlake Boulevard/Pacific Place intersection. Delays for general purpose traffic would increase compared to Option A, B, or C.

The southbound transit trip would increase to 6 minutes and 28 seconds due to the increased travel distance and intersection delay along Montlake Boulevard at Pacific Street and Pacific Place. Southbound transit trips for Option E would be routed through the congested southbound through movement at Montlake/Pacific Street similar to Option D, rather than access the transit/HOV queue jump from Pacific Street to Montlake Boulevard. This could be improved by providing a transit only through lane on Montlake Boulevard through the Pacific Street intersection that would connect into the HOV lane starting near the Montlake cut. With this change, the southbound route would still have over a 5 minute travel time.





### Pedestrian Walk Times

Northbound		
To	Distance	Time
1	1515 ft	6 min 42 sec
2	620 ft	2 min 35 sec
3	At stop	At stop
Southbound		
To	Distance	Time
1	1515 ft	6 min 42 sec
2	620 ft	2 min 35 sec
3	At stop	At stop

### Transit Travel Times

Northbound	5 min 26 sec
Southbound	6 min 28 sec

### Option E Travel Times - Person delay while riding transit

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	3 min 25 sec	341 hr 40 min
SB	6,000	5 min 06 sec	510 hr 0 min

**Benefits:** Bus riders transferring to the UW station or going to UW athletic complex would have direct access. This is an off-street bus stop and limits impacts to traffic operations along Montlake Boulevard.

**Challenges:** Bus riders heading to UW campus or the UW Medical Center would experience increased walk times of approximately 2-4 minutes compared to existing conditions. Transit riders traveling through the Montlake Triangle area would experience longer travel times, a delay of 4-5 minutes compared to existing conditions. Traffic operations at Montlake Boulevard/NE Pacific Place would be impacted as described above due to the added signal phase required for the westbound exit from the stadium area. Transit operations during special events would require temporary on-street bus stops. Service to this location would require additional infrastructure, including construction of a transit center, and if trolley buses were to serve this off-street location, additional trolley wire. Bus circulation through the UW parking area may be difficult to accommodate due to physical

constraints near the parking facilities, bus movement, and potential conflicts or delays with other vehicles accessing the parking lots. Transit could not use inside HOV lanes planned for northbound Montlake Boulevard or the transit/HOV lane configuration would need to be re-evaluated to have the lane serve this stop.

*Option F*

*Transit circulation/drop-off through Stadium parking lot:* As in Option E, bus stops would be located adjacent to the UW station within the Husky Stadium parking lot. Buses would enter the area at the intersection of NE Pacific Place and Montlake Boulevard, stop adjacent to the UW station, then exit at the intersection of NE Pacific Street and Montlake Boulevard. This option would require the construction of a transit center to accommodate northbound and southbound buses at this location.

Option F includes signal and capacity modifications at the Montlake Boulevard/Pacific Street intersection. A westbound through and a left turn lane would need to be provided to allow buses to exit the UW station lot. The Montlake Boulevard/Pacific Street intersection would degrade to a LOS F, and would be 48% over capacity even with the recommended lane additions. This results in an 82% increase in delay for all vehicles travelling through the Montlake Boulevard/Pacific Street intersection. Congestion levels this high would likely cause queues that extend through adjacent intersections, which would affect transit trips beyond the travel time captured in the table below.

Northbound transit trips would be required to travel through the Montlake Boulevard/Pacific Street intersection twice, resulting in a travel time that exceeds 8 minutes. Southbound routes would travel through this intersection as well and would experience travel times over 3 ½ minutes.



### Pedestrian Walk Times

Northbound		
To	Distance	Time
1	1515 ft	6 min 42 sec
2	620 ft	2 min 35 sec
3	At stop	At stop
Southbound		
To	Distance	Time
1	1515 ft	6 min 42 sec
2	620 ft	2 min 35 sec
3	At stop	At stop

### Transit Travel Times

Northbound	8 min 50 sec
Southbound	3 min 38 sec

### Option F Travel Times - Person delay while riding transit

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	3 min 34 sec	356 hr 40 min
SB	6,000	2 min 11 sec	218 hr 20 min

**Benefits:** Bus riders transferring to UW station or going to UW athletic complex would have direct access. This is an off-street bus stop and limits impacts to traffic operations along Montlake Boulevard.

**Challenges:** Bus riders heading to the UW campus or UW Medical Center would have to cross Montlake Boulevard and/or NE Pacific Street, resulting in longer walk times of approximately 2-4 minutes compared to existing conditions. Transit riders traveling through the Montlake Triangle area would also experience longer travel times, a delay of 2-7 minutes or more compared to existing conditions. The Montlake Boulevard/Pacific Street intersection would operate at well over capacity, impacting all traffic travelling through the intersection. Service to this location would require additional infrastructure, including construction of a transit center, and if trolley buses were to serve this off-street location, additional trolley wire. Bus circulation through the UW parking area may be difficult to accommodate due to physical constraints near

the parking facilities, bus movement, and potential conflicts or delays with other vehicles accessing the parking lots. Transit operations during special events would require temporary on-street bus stops. If all bus service inbound to the Triangle area used this stop, a longer signal for westbound movement at Montlake Boulevard/NE Pacific Street would be required to allow buses to move through the intersection. Any additional signal time at this location would result in substantial congestion on Montlake Boulevard and NE Pacific Street. Transit could not use inside HOV lanes planned for northbound Montlake Boulevard or the transit/HOV lane configuration would need to be re-evaluated to have the lane serve this stop.

#### *Option G*

*Northbound on Montlake Boulevard, south of Stadium parking entrance.* This northbound stop would be located just south of the E-12 parking lot and Husky Stadium access road. Bus riders would be required to cross the Husky Stadium access road to reach the UW station, assuming that local and regional bus transit riders are seeking a transfer to light rail destined north or south of the UW campus.

Option G includes signal and channelization modifications at the Montlake Boulevard/Pacific Street intersection. To provide a right side bus stop on Montlake south of Pacific Street and allow buses to travel northbound on Pacific Street, a bus-only signal phase would need to be provided. Adding this phase to the signal operations would result in substantial congestion that would extend back through the SR 520 interchange area, affecting local buses south of the SR 520 interchange. Without additional simulation analysis for the peak period, the level of travel time effect could not be quantified. To achieve the transit travel times shown in the table, an HOV bypass lane would need to be constructed for the length of the general purpose congestion.

The Montlake Boulevard/Pacific Street intersection is forecasted to operate at LOS F in the No Build condition. The additional green time for signal movement results in a 79% increase in delay per vehicle. Southbound transit trips would operate similarly as Options A, B, or C because they would use the existing HOV/transit lane on Pacific Street.



### Pedestrian Walk Times

Northbound		
To	Distance	Time
1	1520 ft	7 min 43 sec
2	1040 ft	4 min 36 sec
3	455 ft	2 min 10 sec
Southbound		
To	Distance	Time
1	740 ft	3 min 52 sec
2	790 ft	4 min 5 sec
3	1010 ft	5 min 13 sec

### Transit Travel Times

Northbound	3 min 39 sec
Southbound	1 min 42 sec

### Option G Travel Times - Person delay while riding transit

(SB Option G assumed to have no travel delay compared to existing condition)

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	1 min 29 sec	148 hr 20 min
SB	6,000	0 min	0 hr

**Benefits:** This stop location would benefit riders transferring to light rail and does not impact plans for Husky Stadium expansion.

**Challenges:** Bus riders heading to the UW campus or the UW Medical Center would have to cross Montlake Boulevard and/or NE Pacific Street, resulting in

approximately 2-5 minutes of additional walk time compared to existing conditions. Transit riders traveling through the Montlake Triangle area would experience travel time delay of 2 minutes or more, compared to existing conditions. General purpose traffic would be impacted by the traffic signal modifications as discussed above. Northbound Option G requires a transit priority signal for left turn movement onto NE Pacific Street from the bus stop. During the green light, buses would remain at the stop until the next signal phase because a bus could not complete a left turn in front of traffic on northbound Montlake Boulevard. Transit could not use



inside HOV lanes planned for northbound Montlake Boulevard or the transit/HOV lane configuration would need to be re-evaluated to have the lane serve this stop.

#### *Option H*

*Montlake Triangle clockwise bus circulation.* Bus stops H1 and H2 exist today. Northbound buses could be routed around the Montlake Triangle, turning left from Montlake Boulevard to NE Pacific Street followed by a right turn onto NE Pacific Place. Southbound buses would turn left from NE Pacific Street to Pacific Place. Both buses would make a right turn onto Montlake Boulevard and serve a southbound stop near the Montlake Boulevard/Pacific Place intersection, providing a connection to the Montlake Boulevard overcrossing to the UW station. Buses continuing northbound would turn right onto Montlake Boulevard from this stop and right onto NE Pacific Street, and continue to 15th Ave NE. Buses continuing southbound would turn right onto Montlake Boulevard and continue south toward SR 520.

The northbound H2 location is currently served by three daily trips by the Route 243 and a bus stop at this location is in the current plans for the Sound Transit UW station project and the current Montlake Triangle Improvement Plan. Increasing the number of bus routes serving the northbound and southbound stops would require creating 220-foot in-lane stops.

Option H uses existing signal phases and intersection channelization. Northbound transit trips are assumed to stop three times: twice at the stop on Pacific Street, and once on Montlake between Pacific Street and Pacific Place. The route is lengthened by circling the Triangle, resulting in a travel time of over 4 minutes.

The southbound routes are also lengthened by circling the northern section of the Triangle as described in Option D. Southbound transit trips would be routed through the congested southbound through movement at Montlake Boulevard/Pacific Street rather than access the transit/HOV queue jump from Pacific Street to Montlake Boulevard. This could be improved by providing a transit only through lane on Montlake Boulevard through the Pacific Street intersection that would connect into the HOV lane starting near the Montlake cut. With this change, the southbound route would still have over a 2 minute travel time.


**Option H Travel Times - Person delay while riding transit**

	Estimated through passengers	Travel time delay per passenger	Total daily person delay
NB	6,000	2 min 10 sec	216 hr 40 min
SB	6,000	1 min 30 sec	150 hr 0 min

**Pedestrian Walk Times**

Northbound H <sub>1</sub> (NW corner)		
To	Distance	Time
1	660 ft	3 min 8 sec
2	535 ft	2 min 14 sec
3	926 ft	3 min 52 sec
Northbound H <sub>2</sub> (NE corner)		
To	Distance	Time
1	1200 ft	5 min 0 sec
2	380 ft	1 min 35 sec
3	390 ft	1 min 38 sec
Southbound (NE corner)		
To	Distance	Time
1	1200 ft	5 min 0 sec
2	380 ft	1 min 35 sec
3	390 ft	1 min 38 sec

**Transit Travel Times**

Northbound	4 min 6 sec
Southbound	3 min 11 sec

**Benefits:** Riders bound for UW campus would experience relatively short walk times. Bus riders transferring to UW station or going to the UW athletic complex would have more direct access from the southbound stop. Traffic improvements along NE Pacific Street are slightly improved as this option removes the existing southbound in-lane bus stop.

**Challenges:** Transit riders traveling through the Montlake Triangle area would experience a travel delay of approximately 1 ½ -3 minutes, compared to existing conditions. Transit operations are impacted, as buses would stop three times during the loop to accommodate riders boarding and alighting at the NE Pacific Street stop. This would potentially create confusion for riders trying to board buses as they travel northbound: they may be uncertain if

they will have to travel through the bus circulation prior to reaching their destination. Southbound buses could not use the HOV lane and queue jump at the NE Pacific Place/Montlake Boulevard intersection, resulting in impacts to bus travel times and traffic operations.

### Summary

The following tables provide a summary of distances, walk times, transit travel times, and person delays in the Montlake Triangle area.

#### *Pedestrian walk times and distances*

The majority of bus riders and pedestrians (60%) will be destined for the UW campus or Medical Center. As shown in the two charts below, while Options D, E, F, and H offer the shortest walk distance and walk time to the UW station, only 20% of riders are headed to this destination. Options D, E, F, and G would significantly increase the walk distance to UW campus and Health Sciences facilities compared to current conditions and to Options A, B, and C.

Figure 3 (September 2010). Overview of pedestrian walk times (minutes) from northbound stop locations.

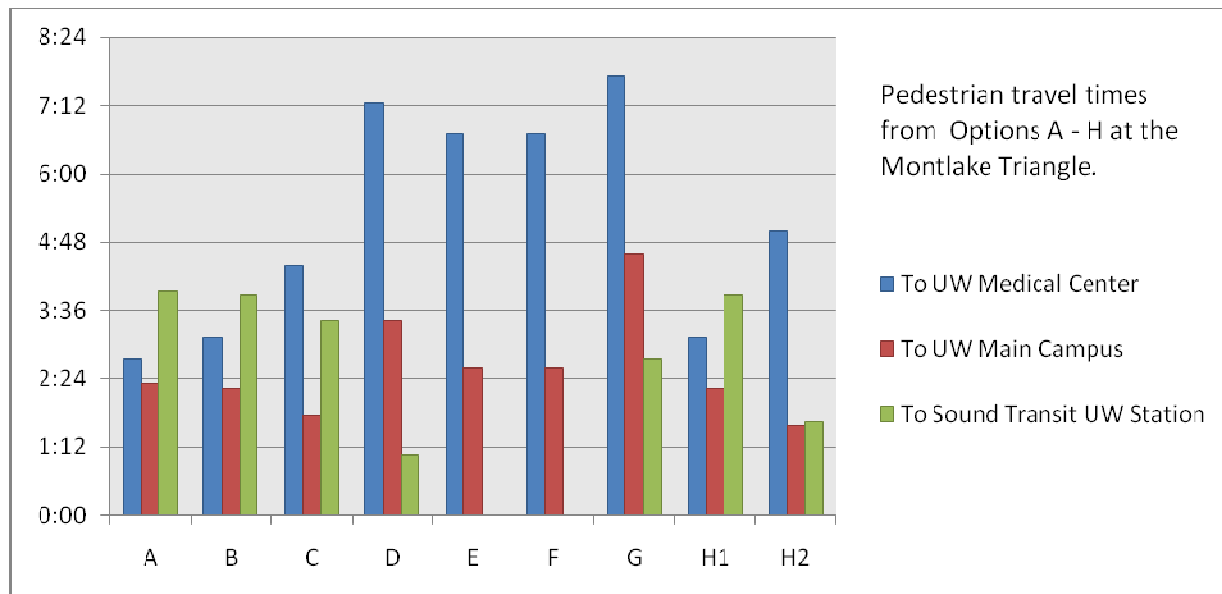
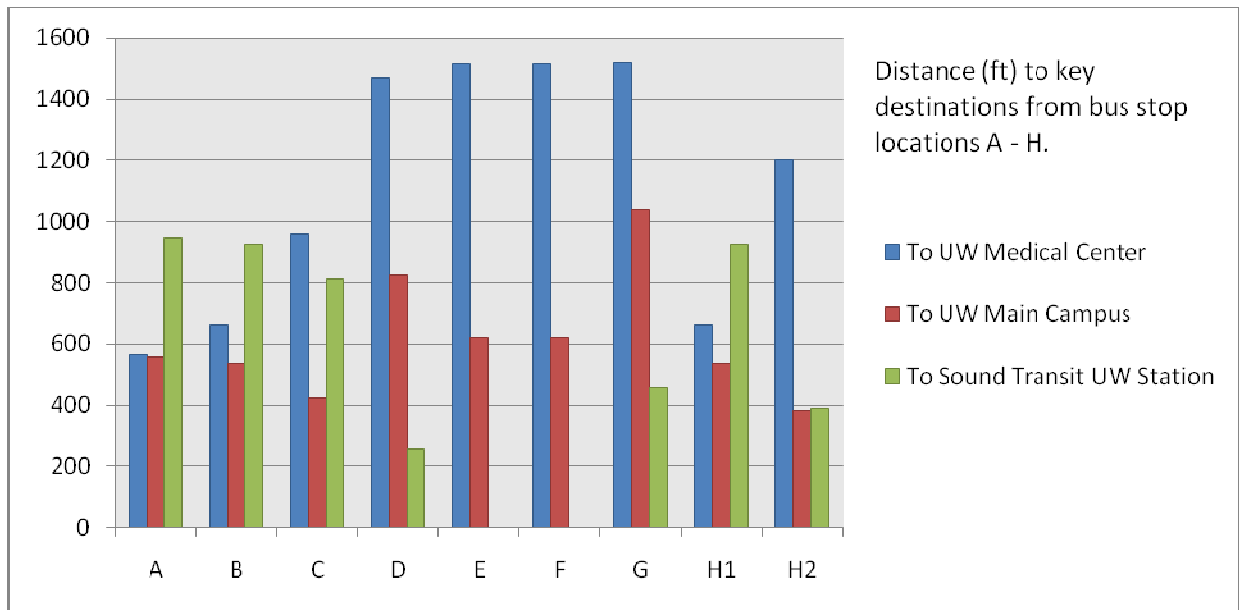


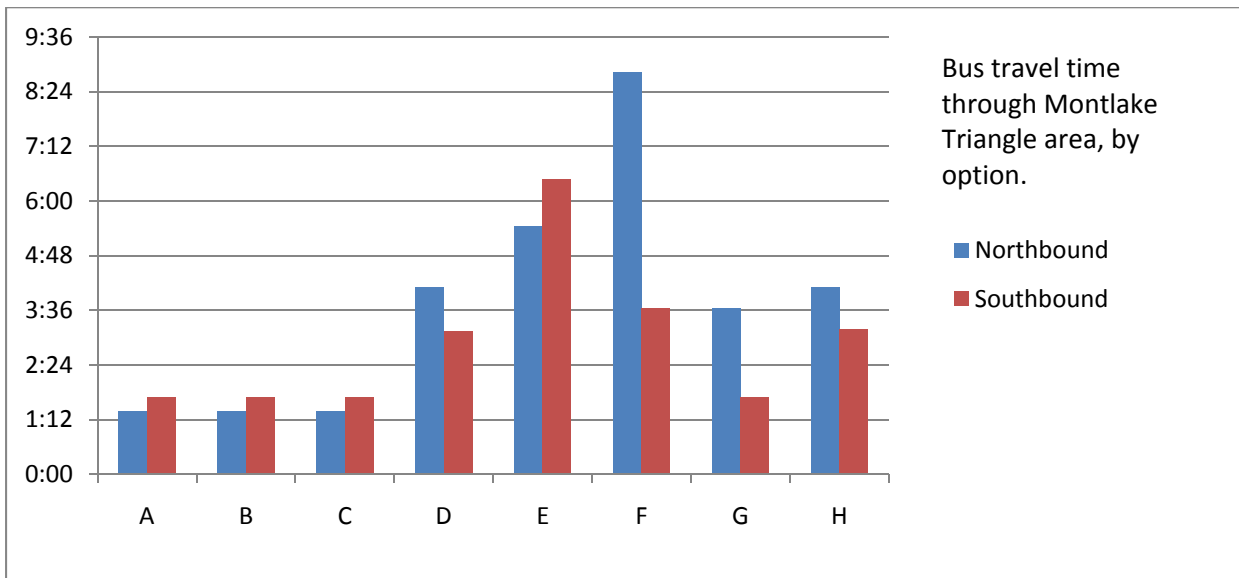
Figure 4 (September 2010). Overview of walking distances (feet) from northbound stop locations



#### *Transit travel times*

Options D, E, F, G, and H also increase the transit travel times for riders continuing through the area, relative to Options A, B, and C. This delay is especially pronounced for Options E and F, as buses are routed off-street through the existing Husky Stadium parking lot to the UW station entrance.

Figure 5 (September 2010). Overview of transit travel times (minutes)

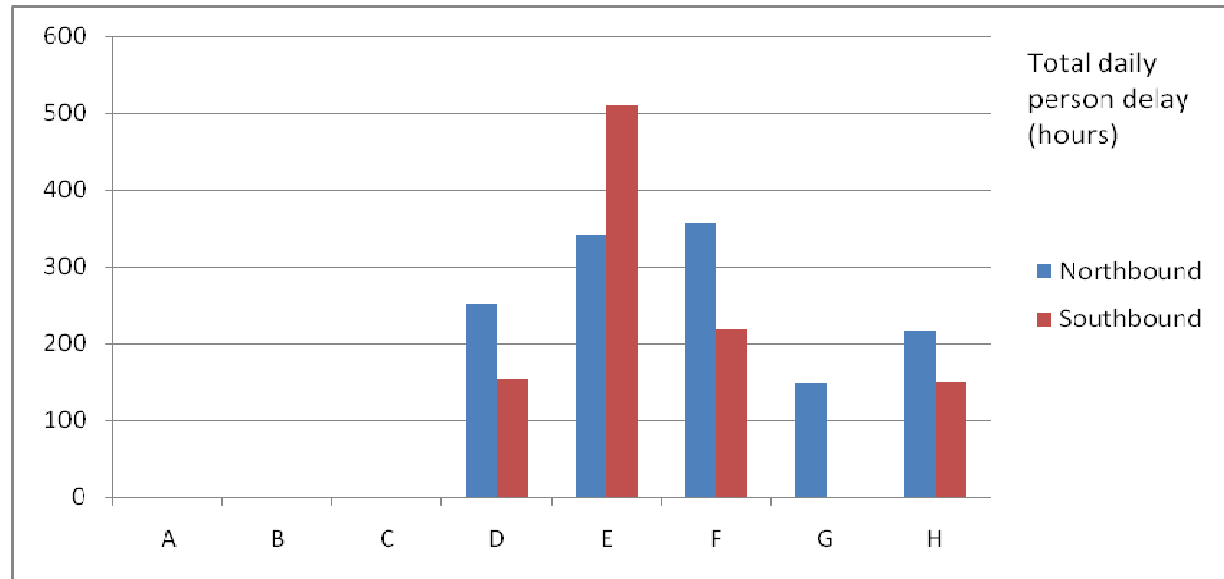


#### *Total daily person delay*

Options A, B, and C all assume no appreciable routing change through the Montlake Triangle and are therefore assumed equal to baseline conditions, resulting in no additional travel time delay for riders. Options E and F cause the most delay because they require all transit service to

detour off Montlake Boulevard and into the Husky Stadium parking lot to service the Sound Transit UW station. This results in a delay of 200-500 hours daily for each direction, equating to a delay of 2-5 minutes per rider. Options D and H add 150-250 hours daily to through passengers in each direction who must now ride around the Triangle, past the Northeast corner, before continuing northwestward on NE Pacific Street or south on Montlake Boulevard.

Figure 6 (September 2010). Overview of total daily person delay (hours)



Note: Options A, B, C, and southbound G are assumed to have no travel delay compared to baseline conditions today.

### *Traffic operations*

Traffic operations for Options A, B, and C are not changed from the existing conditions or the planned improvements from the SR 520 project and the UW station project. Options D, E, F, G, and H would have added traffic impacts along Montlake Boulevard, NE Pacific Street, and NE Pacific Place, including:

- In-lane stops on Montlake Boulevard for Options D and G northbound could cause traffic delays.
- Option D requires a northbound left turn from Montlake Boulevard to NE Pacific Place, resulting in traffic, roadway, and sidewalk impacts on Montlake Boulevard.
- Options E and F require bus circulation through the Husky Stadium parking lot that would require close coordination with the UW station and Husky Stadium projects. Operations during special events would require on-street bus stops.
- Option F would require a longer signal for the westbound movement on Montlake Boulevard/ NE Pacific Street.
- Northbound Option G requires a transit priority signal for left turn movement onto NE Pacific Street from the stop. During the green light, buses would have to remain at the stop until the next signal phase, because a bus could not complete a left turn in front of northbound Montlake traffic.
- Option H requires buses to stop twice around the Montlake Triangle loop.



### *Recommendations for the Montlake Triangle stops*

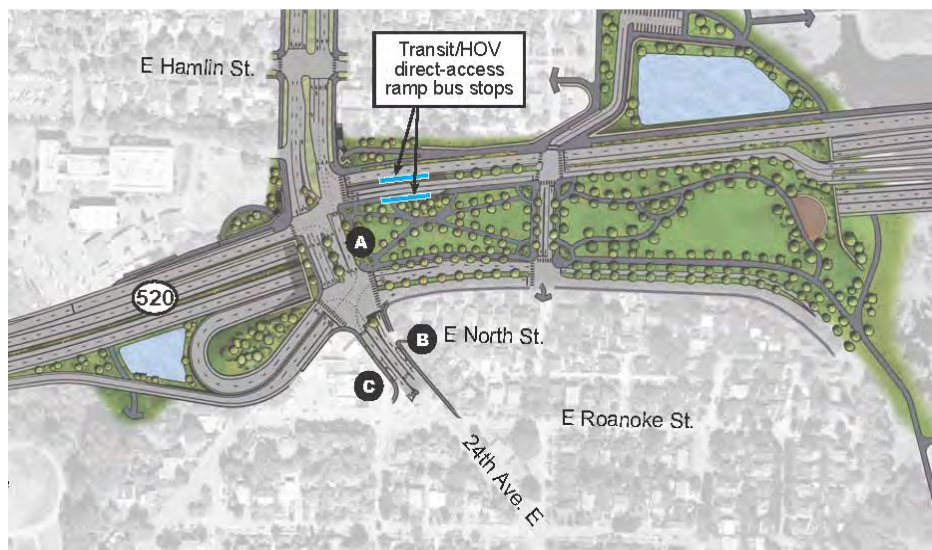
Bus stop Options A, B, and C are recommended for further evaluation and inclusion for short term improvements at the Montlake Triangle area. This evaluation should include ridership estimates that include the light rail extension to Northgate, the associated reorientation of local bus service that will accompany the extension, and should include average pedestrian walking times in the overall travel time. Each stop location offers the majority of transit riders the shortest walk distance to/from destinations on the UW campus and UW Medical Center, similar to what is currently experienced today. Transit riders transferring from bus-to-bus or bus-to-light rail are served by walk distances of 950-1010 feet, and walk times between 4 and 5 minutes. Riders transferring at this location will have improved connectivity via new pedestrian pathways and a new bridge over Montlake Boulevard connecting the Triangle to the UW station. To improve the walk time for the southbound stop next to the UW Medical Center, an additional crosswalk at the existing access signal should be evaluated. There is no significant impact to traffic operations or added travel time for riders with these options.

Bus stop Options D through H are not recommended for further consideration at this time. These options offer some benefits and could be implemented as continued transit planning efforts identify additional service and bus stop needs to address transit riders and pedestrian. Options D through H are not precluded by the initial implementation of Options A, B, or C. However additional infrastructure and traffic operations improvements are required to provide service at these locations. Northbound stops for Options D and G would require improvements to the existing stops such as 220-foot bus bays, additional sidewalk and curb space, and platforms. Options E and F would require construction of a transit center to serve all northbound and southbound routes in this area. Options D, E, F, and G would require signal and channelization changes to maintain traffic level of service and transit speed and reliability.

### Bus stop location options for the Montlake interchange

The preferred alternative design provides an opportunity to consider consolidating and relocating bus stops on the Montlake lid and along Montlake Boulevard. Using local and regional transit ridership projections, the subgroup evaluated options for bus stop locations at the Montlake interchange.

Figure 7 (August 2010). Bus stop location options at the Montlake interchange.



*Stop A: Northbound—locate a bus stop on the Montlake lid.*

*Benefits:* This option benefits transit riders by reducing the walk distance between the regional and local transit stops. This allows riders to use these stops as a transfer point between local and regional buses, replicating the function of the Montlake Freeway station, which is removed as part of the Preferred Alternative. This option also provides general purpose traffic with two lanes for passing stopped buses.

*Challenges:* This option reduces the green space on the lid to accommodate the pull-out. This option requires a transit receiving lane further north of the lid, along the east edge of Montlake Boulevard to Hamlin Street.

*Considerations:* The stop on Montlake Boulevard at East Roanoke would need further evaluation and a public process to determine if it could be consolidated with the Montlake lid stop. Transit signal priority could be considered in the future upon continued review of traffic operations at this location.

*Stop B: Northbound—locate an in-lane bus stop on East Montlake Place East at East North Street.*

*Benefits:* This option decreases walk distance compared to the existing northbound stop location at Roanoke Street.

*Challenges:* Riders accessing regional buses would need to cross Lake Washington Boulevard and would experience increased walk time as compared to Stop A.

*Stop C: Southbound—locate an in-lane bus stop on East Montlake Place East adjacent to the Hop-In Grocery.*

Additional stop locations were considered on the lid but were not considered safe alternatives. The ESSB 6392 process eliminated the “slip ramps” or “free right turn lanes” at this location, which resulted in the removal of all traffic islands from the design. Today, the traffic islands act as a refuge for transit riders for access to buses. Removing the islands eliminates the space for a bus stop at this location.

*Benefits:* This option decreases the walk distance between the regional and local transit stops compared to the existing southbound stop location at Roanoke Street .

*Challenges:* The intersection of East Roanoke Street and East Montlake Place East will require reconstruction to provide the necessary curb space while maintaining business access. This stop also needs further evaluation to identify and resolve any potential transit operational issues.

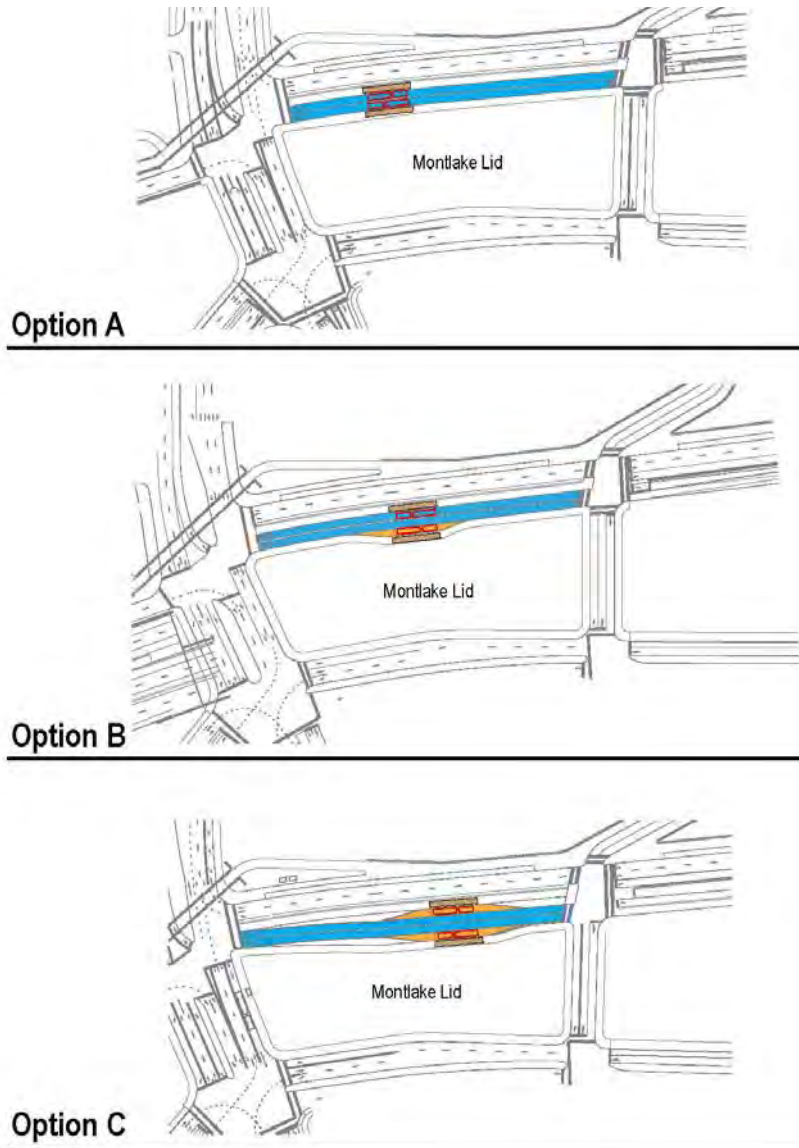
*Recommendations for the Montlake interchange stops*

A northbound bus pull out located on the Montlake lid (Stop A) and the southbound stop located adjacent to the Hop-In Grocery (Stop C), are recommended. These locations provide the most effective service for planned transit routes. The locations are also closest to the proposed bus stops on the direct-access ramps, facilitating easy transfers between local and regional bus transit service for riders.

Bus stop options for the direct-access transit/HOV ramps

The graphic below shows the three options for bus stop configurations on the eastbound and westbound direct-access ramps at the Montlake Boulevard and SR 520 interchange.

Figure 8 (August 2010). Bus pull-out options at the direct-access ramps.



*Option A*

This option has no pull outs. Buses stop in-lane on both the eastbound and westbound ramp.

*Benefits:* Buses are not required to re-enter traffic, which facilitates bus movement off the ramp and through the interchange. This option has the least impact to green space on the lid.

*Challenges:* The in-lane stop in the eastbound direction may cause back-ups as vehicles queue on Montlake Boulevard, waiting to complete the left turn movement onto the ramp. This could cause a bus to miss the green movement and have to wait through another signal cycle.

*Option B*

This option has a pull out on the eastbound ramp and an in-lane stop on the westbound ramp.

*Benefits:* The pull out in the eastbound direction reduces the potential for congestion backing onto Montlake Boulevard. Buses in the eastbound pull out would have an opportunity to reenter traffic when the cycle turns red for the southbound left from Montlake Boulevard to the direct-access ramp. The in-lane stop in the westbound direction will cause minimal delay. This option has some reduction of the green space on the lid.

*Challenges:* Appropriate pavement delineation will be required to ensure delayed westbound vehicles do not move in front of a stopped bus, creating potential bus-vehicle conflicts.

*Option C*

This option has pull outs on both the eastbound and westbound ramp.

*Benefits:* This option removes buses from the ramps reducing any additional delays to HOV's using the direct-access ramps.

*Challenges:* This option has the most reduction of the green space on the lid. In the westbound direction, additional delay may be incurred as the bus may need to wait to reenter traffic.

*Recommendations for the direct-access transit/HOV ramp stops*

Traffic operations analysis shows that pull outs are not required in both directions. Option B, with a pull out on the eastbound ramp and an in-lane stop on the westbound ramp, is recommended by the TCT. This option reduces the potential for congestion on Montlake Boulevard while only having a small reduction to the green space on the lid. These stops will be evaluated further in the design process to determine what potential improvements can be made to the passenger waiting environment.

**Final TCT recommendations**

The TCT recommended bus stop locations in three areas: the Montlake Triangle, the Montlake interchange, and the direct-access transit/HOV ramp.

*Montlake Triangle stops*

- Bus stop Options A, B, and C are recommended for further evaluation and inclusion for short term improvements at the Triangle area.
  - Each stop location offers the majority of transit riders the shortest walk distance to/from destinations on the UW campus and UW Health Sciences facilities.
  - Transit riders transferring from bus-to-bus or bus-to-light rail are served by walk distances of 1,010 feet or less.
- Options D through H could be implemented as continued transit planning efforts identify additional service and bus stop needs to address transit riders and pedestrians.

- Options D through H are not precluded by the initial implementation of Options A, B, or C; however additional infrastructure and capital investments are required to provide service at these locations.
- Options D, G, and H would require improvements to the existing stops such as 220-foot busy bays, additional sidewalk and curb space, and platforms.
- Options D through H may have traffic impacts that affect general-purpose and transit traffic.
- Options E and F would require construction of a transit center to serve all northbound and southbound routes in this area.

*Montlake interchange stops*

- A northbound bus stop and receiving lane located on the Montlake Lid (Stop A) and the southbound stop located adjacent to the Hop-In Grocery (Stop C), are recommended. These locations provide the most effective service for planned transit routes, and are closest to proposed bus stops on the direct-access ramps.

*Direct-access transit/HOV ramp stops*

- A pull out is recommended on the eastbound direct-access transit/HOV ramp, and an in-lane stop is recommended on the westbound ramp (Option B).